Tampa Bay Estuary Program Values Assessment: Charting Publicly Preferred Passages

Proposal submitted to

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by

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Executive Summary

The goal of the proposed program of research is to identify and assess public environmental values associated with the Tampa Bay Estuary Program (TBEP) effort to restore and protect the ecological health of the bay by reducing (or halting increases in) aquatic nitrogen pollution. Specifically, the assessment will determine public preferences for nitrogen management options and associated ecological conditions to provide insight into the nature of and the bases for current and future public support for the TBEP effort. The study will illustrate the application of computer-based interactive survey methods being developed in the context of other environmental quality and risk assessments.

The TBEP (established in 1991) has set the goal of holding nitrogen loads in the bay to 1992-94 levels and restoring sea grass coverage to 1950 levels (minus permanently altered areas). Bay-wide nitrogen targets are achieved by a voluntary trading scheme in which increased loads from one source are balanced by reductions in another. The program has enjoyed substantial community support and nationally recognized success. Projected increases in population and development in the bay watershed will contribute additional nitrogen to the bay, so continued active management will be required to balance contributions from new sources against reductions in existing sources. As achieving nitrogen-reduction targets becomes more costly, currently agreed upon nitrogen load targets may be challenged, along with the associated ecological/sea grass protection goals. In this context, better understanding of relevant public beliefs and preferences will be important to guide policy-making and to build the public support needed to implement and sustain the TBEP management programs.

To establish the relevant temporal and geographic context for the assessment, historic and contemporary environmental and social conditions will be presented to participants through computer graphic and environmental data visualization systems. A converging operations research strategy will separately assess public preferences for alternative nitrogen management/outcome scenarios by verbal-questionnaire, conjoint-rating and scenario-creation procedures. Preferences expressed in each of these contexts will be appropriately scaled and quantitatively related to physical parameters of total nitrogen (with associated sea grass coverage) and to the relative contributions of nitrogen from different sources. Obtained psychophysical relationships between preference indices and nitrogen pollution parameters will be compared across different stakeholder and general public samples to determine points of convergence and divergence in relevant public values, and to test the generalizability of findings. Comparison of findings between elicitation methods will be used to gauge the convergent validity of the assessment.

Specific Aims

The goal of the proposed program of research is to identify and assess public environmental values associated with the Tampa Bay Estuary Program (TBEP). The proposed assessment specifically seeks to determine the nature of and the bases for current and future public support for the TBEP effort to restore and protect the ecological health of the bay by reducing (or halting increases in) aquatic nitrogen pollution. The principal strategy is to secure sufficient voluntary reductions in nitrogen contributions from many individual sources to compensate for expected increases in overall nitrogen as the bay area population continues to grow. Of particular interest is the Tampa Bay community's understanding of and support for efforts to reduce contributions from atmospheric nitrogen deposition. In addition to these site-specific assessment objectives, the study will illustrate the application of computer-based interactive survey methods being developed principally in the context of assessing public perceptions of environmental quality and natural hazards in forest environments.

The proposed value assessment objectives are complementary with, but distinct from other potentially important valuation goals. Different valuation methods would be needed to address the value/worth of Tampa Bay (as compared to other bays, or other environmental or social resources), the economic impact of Tampa Bay (on local, regional or national economies) or the cost/benefit efficiency of the TBEP (responding to program evaluation regulations). Similarly, different methods would be required if the goal were to negotiate and resolve conflicts among potentially competing interests (e.g., commercial versus recreational fishers) or to devise or evaluate alternative political/administrative schemes for furthering the attainment of environmental policies or management objectives of the TBEP. The proposed assessment will contribute to a comprehensive policy valuation by illuminating and quantifying the relative preferences of contemporary citizens of Tampa Bay for an array of alternative nitrogen management strategies.

Contemporary preferences for alternative nitrogen management policies and associated environmental conditions are taken to be an indicator of future preferences, and the basis for predicting public support for (and/or compliance with) those policies/conditions when they are encountered in the future. The success of the assessment then depends upon the extent to which projected preferences are consistent with those that are realized when the assessed policies/conditions are achieved. The ultimate *predictive validity* criterion cannot, of course, be affirmed until after the fact, and even then only if the projected management actions and environmental conditions are in fact achieved. Several traditional validity indicators will be derived from the contemporary data, including the consistency of expressed preferences between respondents (*internal reliability*) and the ability of the preference measures to discriminate between the policy/outcome options assessed (*discriminant validity*). The consistency of preferences within respondents (e.g., transitivity) will also be investigated. Observed violations of prescribed rules of valuation logic will be interpreted not so much as a measure of assessment invalidity as an indicator of valuation practices that are likely to be applied by relevant publics in the context of actual environmental experience.

An important feature of the proposed assessment is that parallel applications of different preference elicitation methods will allow measures of *convergent validity.* Where different methods converge on similar conclusions (*method invariance*) confidence in the validity of the assessment is increased. Inspection of inconsistencies between methods will help to identify aspects of the valuation context that may ultimately affect public support for the assessed policies/outcomes in the "real world."

Background and Significance

Post World War II population growth and development in the Tampa Bay watershed had many negative impacts on the health of the estuary. Dredge and fill development around the bay had dramatic and long lasting impacts. By the1970's stormwater runoff from agricultural, industrial and residential developments within the watershed and direct discharge of partially treated wastewater from burgeoning municipalities had devastating effects on the bay. Fish and shellfish stocks were in decline. Estuarine bird populations were reduced to fractions of previous levels. Beaches were frequently unsafe for human use. Nutrient laden runoff and wastewater discharge raised nitrogen concentrations in the bay to over five times previous levels. Algae blooms clouded the water, obstructing sunlight and causing the loss of half of the sea grass beds, and triggering a general ecological decline throughout the bay (e.g., Johansson & Greening, 2000; TBEP, 1996; Wang et al, 1999).

The (US) Clean Water Act (1970) and associated state and local legislation lead to substantial improvements in wastewater treatment systems, sharply reducing nitrogen discharges into the bay. By the early1980's nitrogen loads were reduced to less than half the levels of a few years before. Where dredging, filling and other permanent alterations of the bay did not preclude them, sea grasses began to recover. A 20% increase in sea grass coverage was recorded between the initiation of water quality improvements at the end of the 1970's and 1992. Evidence of commensurate improvements in the general ecological health of the bay was also observed.

Estuary restoration and protection

The Tampa Bay Estuary Program (TBEP) was established in 1991 to address water quality and habitat protection in Tampa Bay. The TBEP successfully adopted a community-wide plan to "hold the line" on nitrogen loads in Tampa Bay to restore and protect the ecological health of the estuary. An extensive nitrogen-monitoring program was established and sea grass coverage was adopted as the key indicator of ecological conditions. A coalition of federal, state and local government agencies and local industries set the goal of holding nitrogen loads in the bay to levels measured in 1992-94, and restoring sea grass coverage to 1950 levels (minus permanently altered areas). The basic strategy is to achieve the bay-wide nitrogen target by a voluntary trading scheme in which increased loads from one source (or one sub-watershed/jurisdiction) are balanced by reductions in another (Bacon & Greening, 1998). In the first five years of the program (to 1996) nitrogen load targets were largely met, and sea grass coverage increased by 20% over the low point recorded in the 1980's. This pattern of improving conditions was temporarily disrupted by substantial increases in nitrogen, with subsequent sea grass losses, triggered by high rainfall in 1997-98 associated with the El Nino. Still, the success of the program has lead to national recognition of the TBEP as a model for community cooperation to achieve estuary restoration and protection. Review of the program in 2001 reaffirmed the hold the line strategy and extended the bay-wide cooperative nitrogen management program (Janicki Environmental, Inc., 2001).

Projected increases in population and development in the bay watershed are expected to contribute additional nitrogen to the bay. Thus, holding the line at 1992-94 levels will require continued active management to balance contributions from new sources against reductions in existing sources. While some reductions can still be achieved by further improvements in wastewater treatments and control of stormwater runoff, the largest current source of nitrogen (at least 29%) is direct atmospheric deposition into the bay (Greening et al, 1997). By some estimates when nitrogen deposited on land within the watershed and subsequently washed into the bay is included, the contribution from atmospheric sources rises to over 60%.

Airborne nitrogen is primarily derived from industrial point sources (estimated at 70%), especially coal-fired power plants around the bay, and mobile sources including cars, trucks and boats (30%). Determining the actual contribution of point sources is complicated by atmospheric transport into and out of the bay watershed. While mobile sources represent a smaller proportion of nitrogen emissions, most of this source is deposited in the local area.

Public support

The success of the TBEP to date is undoubtedly based on the very effective coalition that has been formed among government agencies and relevant industries in the bay area. Community interest in bay conditions is encouraged by the proximity and visibility of the bay, and by the fact that a clean and healthy bay directly and indirectly contributes to a wide array of benefits appreciated by most residents and visitors. While there is certainly the potential for conflicts among different users, the overwhelming theme is that all benefit from an ecologically healthy bay.

The actions that produced the impressive improvements in bay conditions in the 1980's and 90's have enjoyed substantial public support--or at least have met with little public resistance. In part this may be attributed to the widely recognized unhealthy condition of the bay at the time, and the undeniable need (strengthened by health-related legal requirements) to improve sewer treatment facilities. The problems in the bay were immediate and unambiguous (declining fish stocks, lost or inedible shellfish, unsanitary beaches, murky water) and the linkage to management actions (cease dumping "partially treated sewage" into the bay) could be readily appreciated without elaborate scientific justifications. The dramatic improvements in conditions that followed upgrading of wastewater treatment facilities likely reaffirmed the basis for broad public support.

Maintaining public support for bay restoration and protection in the coming decades, may be more difficult. Current conditions in the bay are quite good compared to conditions likely to be in public memory, so the impetus for management actions (and public concern) is not so strong as it was in the 1980's. While the TBEP's ecological goals call for nearly a 50% increase in sea grass coverage between 1991 and 2010, achieving this goal is largely dependent upon the "hold the line" strategy--keeping bay nitrogen loads at 1992-94 levels in the face of projected growth-related increases. From a public perspective, preventing deterioration of current conditions is unlikely to elicit the same levels of enthusiasm as the dramatic improvements offered in 1970's and 80's. Past improvements were gained by large reductions in substantial and easily identified and understood pollution sources, mostly achieved with little direct public input or awareness. If (when) achieving nitrogen targets becomes more costly (in dollars and life-style compromises), garnering and maintaining broad public support for the program could become much more important, and more difficult than it has been.

Holding to 1992-94 nitrogen levels in the future will increasingly be based on trading off marginal increases and reductions among many different sources. Achieving necessary reductions is likely to require more significant and more direct involvement of the public, such as changing public and residential landscaping practices, increasing costs of electricity and/or constraining automobile and recreational boat uses (TBEP, 1996). In this context, conflicts are likely to revolve around how much bay protection (nitrogen reduction) is to be achieved, at what costs, and to whom. These conflicts will be actualized by the effects of management decisions about how to balance the nitrogen budget for the bay among the multiple contributing sources. Moreover, public appreciation of one of the key target sources, atmospheric deposition, may depend upon understanding (and believing) a rather complex chain of physical, chemical and biological processes and reactions that have only recently been fully recognized by scientists (Greening et al, 1997).

Future policy contexts

General public support for keeping Tampa Bay clean and healthy is likely to continue to be strong. An aggressive and well-conceived public education campaign has laid an important foundation for community-wide understanding and support of the TBEP nitrogen management program. Public support is not likely to be seriously tested in the immediate future, however, as most near term nitrogen load targets (e.g., the 2010 target) are already assured (or exceeded) by ancillary reductions in point-source contributions associated with the conversion of major coal-fired power plant (Janicki Environmental, Inc., 2001).

In some respects this "reprieve" could exacerbate resistance in the future when achieving further nitrogen reductions will likely require actions that have more direct impact on the public. Nitrogen load allocations among industries and between jurisdictions can be expected eventually to become more consequential, and more controversial. The current voluntary trading scheme may be challenged, providing impetus for a shift toward more formal regulations setting nitrogen loads and source allocations. The public may well care whether the costs of future nitrogen controls come in the form of rising taxes, increased utility bills or constraints on their transportation choices. Communities associated with cleaner segments of the bay may resent paying any price for pollution being generated in other parts of the bay. The currently agreed upon 1992-94 bay-wide nitrogen load target may be challenged, along with the associated 1950-based sea grass/ecological protection goals. In this context, better understanding of public beliefs and preferences regarding ecological goals and nitrogen management options will be important for guiding policy making and for building the public support needed to implement and sustain the TBEP management programs.

Research Design and Methods

The proposed research will identify and assess public preferences and support for alternative nitrogen management strategies for Tampa Bay. Representations of alternative management actions and expected outcomes will be developed from existing documentation and through direct interaction with the scientific and technical staffs of the TBEP and participating members of the Tampa Bay Nitrogen Management Consortium. Historic and contemporary environmental and social conditions relevant to nitrogen management in Tampa Bay will be reviewed and represented to establish the relevant temporal and geographic context for future environmental policy choices. Computer graphic and environmental data visualization systems will be employed to portray projected future environmental and social condition "scenarios" associated with alternative nitrogen management strategies. Following a converging operations research strategy, public preferences for alternative Bay futures will be separately assessed by verbal questioning, by a conjoint rating procedure and by an interactive scenario-creation procedure. Preferred nitrogen management goals and nitrogen source-allocations will be compared across different stakeholder groups to determine points of convergence and divergence in relevant values, and to assess the generalizability of findings and conclusions. Comparison of findings between methods will be used to gauge the convergent validity of the value assessment.

Following a psychophysical approach, public preferences for alternative nitrogen management scenarios will be quantitatively related to specific components of relevant nitrogen-reduction management actions, specifically the setting of total nitrogen loads and the allocation of loads across sources. The first stage of the assessment will focus on the articulation and representation of relevant biophysical and social conditions associated with historic, contemporary and projected future nitrogen-load/ecological-quality scenarios in Tampa Bay. In this stage detailed designs and materials for the conjoint rating and scenario-creation value assessment procedures will be developed, tested and refined. The second stage of the assessment will identify and articulate public perceptions and understandings of nitrogen management-relevant environmental values through a series of small group sessions representing key stakeholder and resident groups in the Tampa Bay community. Small group sessions will contribute directly to the values assessment, and they will also be used to develop a shorter, "distilled" values assessment procedure to be applied to a larger general public sample in the next stage of the research. The third stage of the assessment will culminate in a survey of a broader sample of the Tampa Bay community to test and extend the generalizability of the findings and conclusions from the more intensive small group sessions.

Data collected in the small groups and the general survey will be analyzed and findings and conclusions will be summarized and presented for review to representatives of the TBEP, other interested environmental management agencies and public stakeholder groups. Feedback regarding the overall findings and conclusions of the assessment from both management and public perspectives will be incorporated into the final report of findings, conclusions and recommendations for the TBEP.

Stage 1: Nitrogen management scenarios

The key objectives for this stage of the research are to assemble and verify nitrogen management relevant biophysical conditions and relationships in Tampa Bay and to develop representations of those conditions and relationships that can be readily comprehended by the public in a values assessment context. Conditions and processes represented by scientific environmental data will be translated into "scenarios" to represent relevant management alternatives and outcomes to public participants. Data visualization technologies and geographic information system modeling and display systems will be combined with interactive computer graphics and verbal (voiceover) narration to communicate appropriate aspects of nitrogen management issues and action alternatives and value-relevant outcomes to public audiences.[1]

Biophysical conditions and processes--The relevant geographic context for the proposed value assessment is Tampa Bay (and its sub-bays) and the associated watershed. This area is already represented by a number of excellent historic and contemporary maps, geographic information system (GIS) coverages, aerial photographs and satellite images. Of particular importance are the landuse and

[1] The following characterization of nitrogen management options and relevant public value issues is based on a review of existing documents and a brief field inspection of Tampa Bay and the associated watershed by the investigators. Correspondence and direct interviews have also been conducted with TBEP staff and others familiar with the ecology and management of the Bay and with the history and current status of relevant public knowledge and attitudes in the community. The investigators also attended a meeting of the Tampa Bay Nitrogen Management Consortium at which the last five years (approximately1995-2000) of the TBEP program were reviewed and evaluated, and recommended actions for the next five years (2001-2005) were presented and approved. The activities proposed in the following sections anticipate that substantial additional review and interaction with TBEP and Consortium technical staffs will be required to develop appropriate technically accurate representations of nitrogen management options and outcomes.

drainage maps that are important for showing how stormwater runoff carries nitrogen into the bay, and how stormwater management activities could reduce that flow. Future condition scenarios will be supported by existing maps and data regarding projected population growth and landuse change (development) in the watershed and by model projections of the nitrogen load consequences of those changes.

Relevant environmental conditions are represented by water and air quality monitoring data (with progressively less detailed data prior to about 1995) and sea grass coverage (the selected principal indicator of ecological conditions in the Bay) dating from 1950, with biannual coverage data beginning by the 1990's. The history of significant nitrogen management activities and their effects on nitrogen loads in the bay is another important data resource supporting the development of representations for the proposed values assessment.

Environmental/social condition scenarios--The above-described data sources will be exploited to develop graphic representations of the bay and watershed suitable for presentation to lay public audiences. Scenarios will be developed to represent principal temporal and geographic features of the biophysical and social contexts in which future nitrogen management actions and outcomes are most likely to be encountered by members of the Tampa Bay community. The temporal context for the assessment will begin in 1950, proceed to the present (2002) and then extend by projection to 2010, the end of the current planning-management policy period.[2]

Representations of key nitrogen management-relevant environmental and social conditions in Tampa Bay will be composed primarily of maps (and/or aerial photos-satellite images) highlighting relevant features. Maps will be supported by voiceover narration and a sample of relevant ground level views of familiar sites in the bay area (e.g., views of the bay from bridges, beaches and parks, residential areas, etc). Ground level views will depict indicators of ecological (e.g., sea grasses, water clarity, birds and wildlife) and social (e.g., residential, commercial and industrial development, traffic, relevant recreational facilities and activities) conditions appropriate to the depicted time period.

A general map showing contemporary Tampa Bay, the estuary, the watershed boundary and the surrounding human development will provide an initial introduction

[2] Review of data and projections of changes in nitrogen sources and loads indicates that nitrogen reduction targets for 2010 will likely be met (or exceeded) with little or no direct public action or support, or even the need for significant public involvement. Because of the nitrogen reductions that will accompany the conversion of a key power plant from coal to natural gas, the public is not likely to be faced with any substantial value conflicts in the 2010 time frame. It is recommended that the currently specified planning-assessment horizon be extended to whatever future date would yield projected needs for significant nitrogen reductions. Such an extension would allow pertinent value questions to be raised in the context of more significant potential conflicts requiring actions and tradeoffs that would more substantially affect and involve the public. This extended time frame would create a management policy decision context in which precise and systematic public value assessments would be better motivated and better justified. The proposed procedures that follow assume TBEP targets appropriate to the previous projections (prior to the power plant conversion) that bay nitrogen loads could increase to 5775 tons / year by 2010, without continuing nitrogen reduction actions.

and orientation for small group and (later) general survey participants. This basic map will subsequently be enhanced by addition of a simplified overlay of surface water flows into the bay, with an accompanying narrative explanation to establish the meaning of "watershed" and to provide background for the stormwater runoff issues raised later. Additional versions of the map will feature past, present and future patterns of landuse, highlighting development and other uses that are relevant to nitrogen management in the bay. Maps, accompanied by appropriate voiceover narration and ground-level pictures, will be used to communicate relevant environmental and social conditions for (at least) time periods shown in the table below. In each case these representations will be developed and refined through review and interaction with TBEP and other appropriate technical experts to assure that a valid and accurate representation of the relevant science and data is achieved. An important goal is to clearly communicate relevant social and environmental conditions, without sensationalizing or directing respondent's expressed preferences.

1950	The basis for the nitrogen load/sea grass targets for the TBEP management plan
1976-78	The "low point" in bay conditions just prior to implementation of improved sewer/wastewater treatment systems in neighboring communities
1992-94	The period when substantial recovery of the bay had occurred, and the basis of the nitrogen load and source allocation targets in the TBEP
2002	The "current conditions" for the values assessment
2010	The target time period for which the alternative nitrogen management strategies are to be evaluated

In addition to the above scenarios two brief environmental "tutorials" will be developed. The first will depict a simplified version of the *nitrogen -> eutrophication -> decreased light penetration -> loss of sea grasses* paradigm that is the basis of the TBEP nitrogen management/ecological protection program. Understanding of these relationships is essential for informed decisions about the overall nitrogen management program. The second tutorial will introduce a simplified version of the mechanisms of atmospheric nitrogen deposition into the bay (and watershed). Understanding of this process and source of nitrogen in the bay is essential for informed decisions about the air quality components of the nitrogen source allocation program. Finally, an interactive display system (described below) will be developed to depict different allocations among the various nitrogen sources targeted by the TBEP, and to provide a mechanism for participant's to report their desired overall nitrogen levels (with associated sea grass coverage) and source allocations. As for the condition representations described above, the tutorials and source display system will be developed through a systematic process of review and interaction with TBEP and other appropriate technical staffs to assure an accurate and sufficient portrayal of these key aspects of the nitrogen management processes. Pilot testing with appropriate representatives of public groups will be used to assure comprehension, and to refine materials and presentation procedures.

All orientation, scenario and tutorial materials will be developed in digital formats allowing presentation on individual and/or networked computers. Depending upon features of specific venues and presentation conditions, materials will be delivered over local or wide-area networks. Local networks will be used for the smaller group sessions, while both local and wide-area (www) networks will be used for the general survey. Computer implemented group and general survey procedures provide for a greatly expanded range of presentation media and materials, as well as allowing on-line data collection and automated analysis capabilities to facilitate interactive control and immediate review of results. An additional advantage is that small group procedures can be rigorously standardized and a detailed ‘trace” of the process and outcomes can be recorded for later review.

Stage 2: Small group interactive value assessment

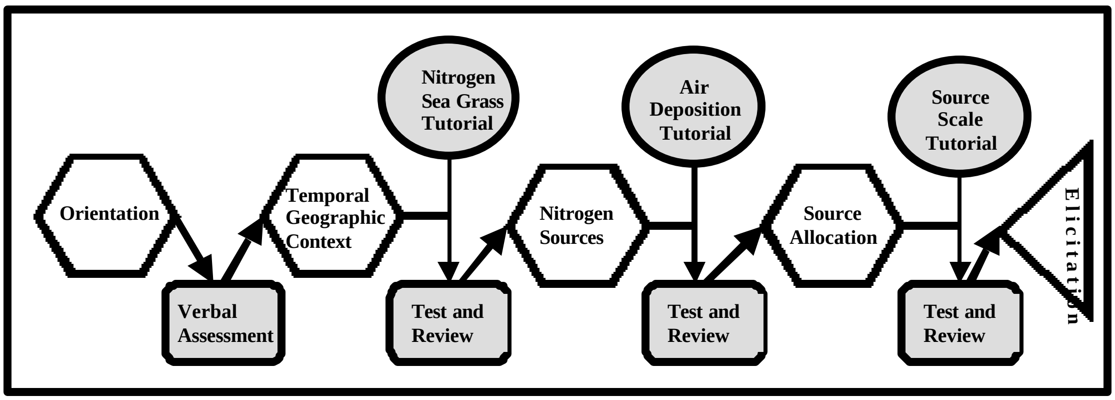
The use of small groups in this stage of the research will allow interactive presentation of issues and a deeper consideration of the bases for expressed preferences. A converging operations strategy will employ three basic presentation/response formats: low-information/verbal response, high-information/conjoint rating and high-information/scenario creation. Results will be compared across methods to find consensus values and to gauge the conjoint validity (method invariance) of expressed preferences and behavioral intentions. Any divergence in findings between methods will be inspected to identify specific methodological and contextual factors that may have important effects on public experience of and preferences for ultimately realized management policies and outcomes.

Participant sampling**—**Selection of participants for the small group sessions is not intended to provide a representative random sample of the Tampa Bay communities. Neither are these sessions intended to induce consensus among the different interests represented, nor are they intended to reach any particular group decisions about bay management options. Rather, the primary goal for this phase of the study is to sample and articulate the range of public understandings, concerns and values relevant to the TBEP nitrogen management program. In this stage of the assessment special attention is given to previously identified stakeholder groups/interests that would likely be influential in determining public support of bay management actions and effects. In that regard, identifying divergences of understandings and preferences is as important as finding consensus.

Preliminary review indicates five primary stakeholder groups with substantial and specific interests in bay conditions: *recreational fishers*, *recreational boaters*, *environmental interest groups* (e.g., Manasota 88), *bay-side residents/property owners* (e.g., Apollo Bay) and *destination tourists*. Additionally, general *residents/citizens* from each of the three counties fronting on the bay (Pinellas, Hillsboro and Manatee) should be represented. Representatives of these eight stakeholder groups (and any others identified) will be recruited and assigned to one of four separate group sessions of approximately 12-16 participants, each composed of a cross section of the identified interests/stakeholders.

Small groups are intended to provide useful value assessments in their own right, but they will also be used to evaluate the efficacy and validity of the developed assessment materials and procedures, and to develop a reduced set of materials and procedures for the subsequent general survey. Prior to implementation, detailed procedures and materials for small group sessions will be developed and refined through a pilot testing procedure using convenient surrogate participants. The goal is to develop a clear and engaging process that can be accomplished in a half-day session.

Small group procedures—The planned components and sequence of small group sessions is summarized in the diagram below.



Each session will begin with a general introduction to the goals and procedures for the session. A brief *Orientation* to Tampa Bay will be followed by an initial *Verbal Assessment*. Sessions will proceed through a series of presentations designed to inform and instruct participants about conditions and processes that underlie the TBEP nitrogen management program. The *Temporal and Geographic Context* will graphically identify the Tampa Bay watershed and review the history of nitrogen-related changes to ecological conditions. A short *Nitrogen-Sea grass Tutorial* will explain the nitrogen-eurotrophication paradigm that is the basis for the nitrogen reduction program. The *Nitrogen Sources* presentation will identify major nitrogen contributors, supplemented by the *Air Deposition Tutorial* that briefly explains how nitrogen in the atmosphere gets into the bay. The *Source Allocation* presentation will identify major nitrogen source classes and subclasses aided by an interactive graphic *Source Scale Display*. Short *Review and Discussion* sessions will be interspersed as shown to monitor participant understanding and to provide opportunities for comments and group discussion. Following this background and context, the preference *Elicitation* will begin using either scenario creation or conjoint rating procedures.

In the *Verbal* A*ssessment* participants will respond individually to a series of verbal questions regarding values (potentially) associated with alternative nitrogen management methods and outcomes. Exact forms and contents of questions will be developed in pilot testing, but key issues are exemplified in the following open-ended questions:

How would you characterize the current condition of Tampa Bay?

> *What are the most important reasons for protecting the ecological health of Tampa Bay?*
> *What do you believe are the most serious threats to the health of Tampa Bay?*
> *What do you think are the best ways to protect the health of Tampa Bay?*

The objective of this initial assessment is to determine participants' preferences based only on existing (pre-assessment) perceptions and understandings of the issues. Responses will include open-ended, checklist and simple rating scale formats typically used in verbal survey assessment methods. Questions will be presented on individual computer screens, and participants will respond individually by entering their ratings, choices or open responses directly. Provisions will be made for those wishing to write out their open responses.

Temporal and geographic context--The next section of the small group sessions will start with the graphic orientation to Tampa Bay and the watershed, using the map/narration/water-flow representation described above. The historic context for the assessment will be established by presenting the 1950 scenario. The map will display the landuse (development) theme. Voiceover narration will report population figures and describe the relevant environmental and social conditions for the represented period, supported by appropriate pictures (wildlife, fish, birds, beaches with bathers, bay with fishermen, sea grasses under clear water) cycled briefly in an inserted window. The voiceover will then describe the population and development growth from 1950 to 1976-78, as the landuse map changes progressively to display 1976-78 conditions. Changing environmental and social conditions will be briefly described, while representative pictures of conditions for the period are shown in the photo window (increasing development and traffic, inflow to the bay, fewer fish, fewer birds, beaches closed, reduced sea grass coverage, murky water) to support the narration. Actual historic photographs will be used where possible, but digital visualizations may be created where appropriate historic sources are not available. The narration will acknowledge the severe effects of dredge and fill development along the shore, and the discharge of "partially treated sewage" into the bay.

Nitrogen pollution will be identified as a major problem producing the depicted ecological decline in the bay in the late 1970s and early 1980s. The *Nitrogen-Eutrophication Tutorial* will be introduced. This short tutorial will employ computer graphics, including some schematic or "cartoon" formats to illustrate the basic processes by which nitrogen pollution affects the health of the bay, with an emphasis on sea grasses as a key ecological indicator. The tutorial will emphasize the effects of excess nitrogen in the bay, pointing out that sea grass recovery typically "lags" behind reductions in nitrogen concentrations.

Following the eutrophication tutorial the presentation will return to the 1976-78 scenario-map. Voiceover will describe the major sewage-plant renovation program in 1978-80, and note the achieved reduction in nitrogen loads (total annual nitrogen was reduced by more than half, and treatment plant contributions dropped from 40% of the total annual load to 10%). The subsequent (delayed) recovery of sea grasses will be described, along with documented improvements in wildlife diversity and numbers and other indicators of the improving health of the bay. Increased population and development to 1992-94 will be described as the watershed map displays the change from 1976-78 landuse. Narration will note that in spite of the increased growth and development, improved wastewater treatment and other management actions allowed nitrogen levels in 1992-94 to remain at less than half of the 1976-78 levels. Description of improved ecological conditions will be accompanied by appropriate ground level photographs (increased wildlife, greater sea grass coverage, clearer water, bathers on the beaches, fishers on the bay, etc).

The map of 1992-94 landuse will progress to current conditions (2002) as the voiceover describes the increase in population and development and the transition to current ecological conditions. Contemporary bay and community photographs will support the presentation. The narration will briefly describe the flush of nitrogen and the declines in sea grasses and general conditions caused by the el Nino rains of 1997-98. The fact that similar nitrogen load increases were observed in other, less developed bays in the region will be noted, along with current indications that bay conditions (sea grasses) are returning to their previous trajectory of improvement.

A short *Review and Discussion* will be interjected at this point in the session to determine respondents' understanding of the geographic and historical context and the eutrophication tutorial. Individual participant's on-line responses to a short series of questions will be analyzed immediately and used to motivate and guide group discussion. As responses indicate, the geo-temporal contexts and nitrogen-eutrophication processes will be reviewed and discussed to clarify any ambiguities or misunderstandings.

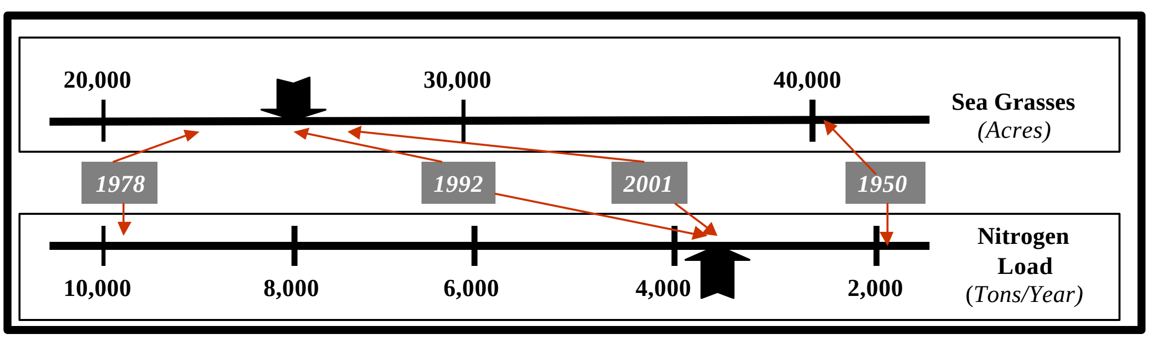
Nitrogen sources--The session will proceed with the return of the initial water-flow overlay map, and the process of nitrogen introduction through runoff will be briefly described. The concept of different nitrogen flows from different landuses will be emphasized and a simple (partial) pie chart will show current (2002) stormwater source contributions, with appropriate "slices" added to the chart as each source (*commercial/industrial/mining*, *agriculture*, *residential* and *undeveloped land*) is described. Direct discharges from municipal wastewater and industrial discharges and chemical/fertilizer spills into the bay will also be described, and these components (slices) will be added to further fill out the chart.

Atmospheric deposition sources (29%) will be introduced. The *Atmospheric Deposition Tutorial* will be presented showing how airborne nitrogen is directly deposited into the bay. Nitrogen deposition on land will also be mentioned, noting that land deposition is ultimately washed into the bay and, by some accounts contributes a substantial portion of the total nitrogen from stormwater runoff (potentially tripling the total nitrogen load derived from atmospheric sources). The issue of local versus regional origins for airborne nitrogen will be raised, acknowledging that most deposition is believed to be from local sources, and that virtually all (mobile-source) emissions from cars, trucks and boats are deposited in the local area. The respective contributions of (point-source) emissions from electric power plants (14.5% of bay total in 1994) and other industries (4.35%) and from (mobile sources) cars, trucks and boats (10.5%) will be identified and described. Finally, the small slice (5%) that represents the (natural) contribution from groundwater (springs) will be added and described.

A second *Review and Discussion* session will focus on nitrogen sources, including the effects of landuse on the amount of nitrogen in stormwater runoff, nitrogen discharge from municipalities (sewer treatment facilities) and industry, including fertilizer loss and spills, and the processes of atmospheric deposition. The goal of this session is to insure that participants understand how different sources contribute nitrogen to the bay and how much nitrogen is currently contributed by each source. Again, participants will respond individually to a short "test," followed immediately by a review of the results and a discussion directed at clarifying any indicated ambiguities, misunderstandings, or disbelief.

Source allocation-- This session will begin by re-presentation and review of the nitrogen-source pie chart. The TBEP-Consortium program to "manage the total annual nitrogen load in the bay by determining the share that each of the various sources contributes" will be briefly introduced. The *Source Scale Display*, illustrated below, will be used to present the concept of load allocation. The scale display will be animated for the presentations described in this section, and will become interactive and used as a response system in the subsequent scenario creation part of the assessment. Total nitrogen (tons per year, T/y) and sea grass (acres) scales will be linked by the historically observed (and modeled future) functional relationship between nitrogen loads and sea grass declines and recovery. Sea grass coverage will be described as the key indicator of the overall ecological health of the bay. TBEP and other relevant expertise will be consulted to assure that the proper functional relationships are accurately portrayed in the display.

The total nitrogen and sea grass scales will be introduced first, with scale markers set and labeled for 1950. This component of the display, with scale markers set for the 1992-94 levels and levels for other time periods noted, is illustrated below.[3]

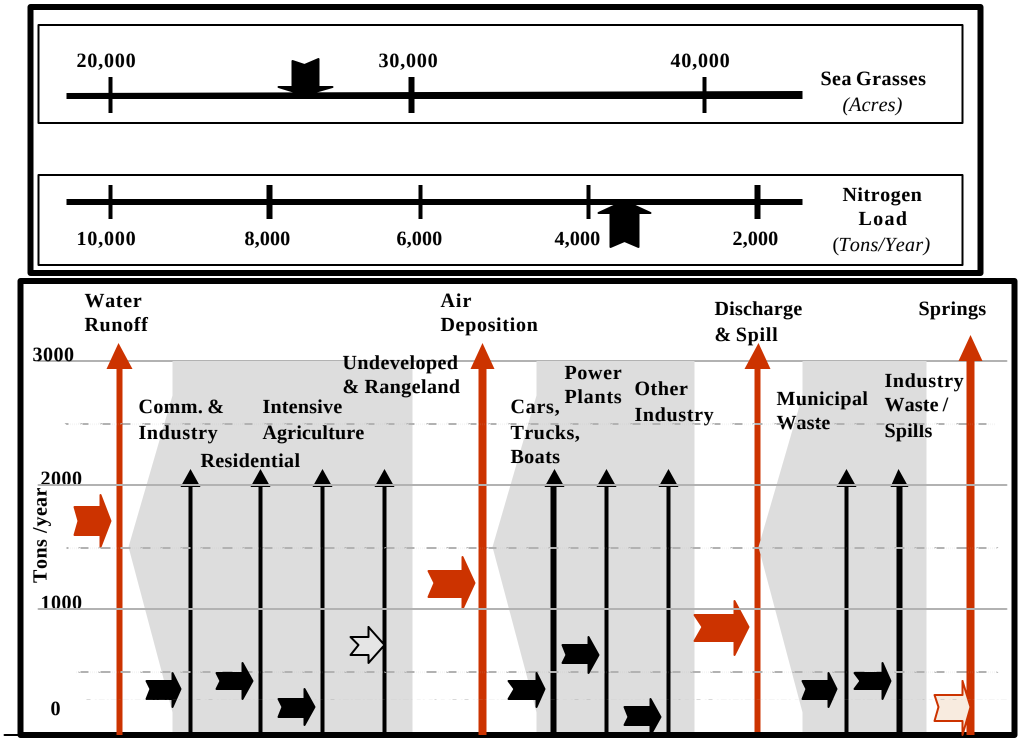


[3] The illustrations included here are sufficient to portray the basic concepts for the source scale display, but the final graphic details of the system will be developed further in the first stage of the project. In particular, the source class and subclass scales will likely be scaled separately, to emphasize the relative differences among subclasses within major classes and to facilitate participant manipulation and interactive use of the scales, as described in following sections of the proposal.

Documentation indicates that total nitrogen load was about 2000 T/y (which will be indicated as approximately the minimum achievable level for modern Tampa Bay) with sea grass coverage at 41,000 acres. Voiceover narration will remind participants of the history of population growth and development in the bay area, including dredging and filling and other developments that permanently removed over 3000 acres of potential sea grass habitat. The sea grass marker will move to 38,000 acres, and the narration will identify this as the estimated maximum remaining potential sea grass coverage for Tampa Bay.

The narrator will review the municipal wastewater disposal and other key nitrogen contributors of the time, as the total nitrogen marker moves to the 1976-78 level (just less than 10,000 T/y). Lagging behind the nitrogen marker, the sea grass marker will move from 38,000 (the noted potential coverage) to just under 22,000 acres (coverage recorded in 1982). Voiceover will review the sewage treatment enhancements in 1978-80, and the nitrogen scales will move to show the recorded reductions in nitrogen load (dropping to just under 4,000 T/y). The total nitrogen marker will move to the 1992-94 position (3800 T/y) as the voiceover briefly reviews the associated increases in development and population, the continuing benefits of the reduced pollution from municipal wastewater discharge and any other significant nitrogen increases or reductions observed over this period. The sea grass scale marker will follow the changes in the total nitrogen scale, after a noticeable delay. Narration will remind participants of the "lag" of sea grass response to changes in nitrogen loads as the sea grass scale moves to about 27,000 acres (the coverage recorded in 1996).

The narration will generally describe the surge in nitrogen loadings observed after the unusually heavy rainfall of 1997-98 attributed to the el Nino. The fact that similar nitrogen surges were observed in other, less developed bays in Florida will be noted, with an emphasis on the variability and uncertainty inherent in complex natural systems. The Total and Nitrogen and Sea grass scale markers will move in consort with the narration (with appropriate time lags), stopping below 25,000 acres (the 1999 level). The nitrogen reductions achieved by the conversion of power plants, and any other significant increases or decreases that have occurred, will be noted as scale markers progressively move in tandem to their current (2002) positions.



The major source class and subclass scales will now be added to the display, as shown above, with markers set at 1992-94 levels (1710 T/y, 1102 T/y, 798 T/y and 190 T/y, respectively for major source classes). Narration will describe the contributions of each of the four major nitrogen source classes (*Stormwater Runoff*, *Direct Discharge*, *Atmospheric Deposition* and underground *Springs*). As each class is described the associated markers will move to their appropriate current (2002) positions on the source class scales. The subclass contributions will then be added and described within each major source class. As each subclass is described the relevant nitrogen contribution markers will be set to the current (2002) T/y contributed by each. It will be noted that contributions from many of these sources have been reduced by environmental management efforts, but that there are "practical limits" to the reductions that can be achieved in Tampa Bay given the current levels of population and development. The estimated "achievable minimum" contribution for each scale (to be determined in consultation with relevant TBEP and other experts) will be described and marked on the respective subclass scales.

Future condition projections--The small group sessions will continue with the *Source Scale Display* being replaced by the map representation of the bay-watershed landuse map showing current (2002) development patterns. The voiceover will describe projected population and development increases to 2010 (or other date), as the developed area displayed on the map changes to reflect projected increases. Projected landuse will be shown in lower color saturation than the existing development and the uncertainty of projected conditions will be noted in the narration. Appropriate surrogate pictures and/or digitally edited scenes will show future increased traffic, additional power plants and other new development based on projections by relevant planning agencies.

The *Source Scale Display* will reappear with all markers set for current (2002) levels. Voiceover will explain that more people, more cars, more energy consumed and more development means more nitrogen in runoff and in the air. Total nitrogen, source class and subclass markers (also in lower saturation color) will move to the projected 2010 (2020) positions with the stated assumption of no action to further reduce nitrogen loads. The sea grass scale will move down to 23,000 acres, the estimated future coverage based the previous 2010 nitrogen projections (5775 T/y in some documents, but updated projections for nitrogen and sea grasses for the appropriate planning period will be used in the proposed study).

The narration will note the TBEP and collaborators' program to "manage nitrogen pollution in Tampa Bay in order to protect the ecological health of the bay" (as indicated by sea grass coverage). The previously noted limits to the amount of reduction that can be achieved for any given nitrogen source will be mentioned, along with the fact that it becomes progressively more difficult to achieve further reductions in a given source as the minimum limit is approached. Some specific ways to reduce nitrogen loads will be briefly described for each source subclass. For example, reducing the load from the Power Plant subclass of Atmospheric Deposition might be described as requiring:

> *Retrofit and/or conversion of existing coal-fired power plants to natural gas and/or more stringent pollution controls on new plants, likely resulting in increased electricity costs for everyone in the Tampa Bay region.*

Where appropriate, potential "fringe benefits" other than protecting bay ecology will also be pointed out. For example, reducing power plant emissions would provide visibility and respiratory health benefits in addition to reducing the level of nitrogen in the bay.

Another brief *Review and Discussion* session will be interjected to ascertain participants' understanding of bay nitrogen sources and the concept of load allocations among sources. A short individual response 'test" will be followed by review and group discussion of results. The various means of reducing contributions from the various subclasses will be covered, along with their respective costs and fringe benefits. The purpose here is to consolidate understanding of current sources and the limits to reducing their respective loads by the various means available, in preparation for proceeding to one of two preference elicitation procedures.

Individual scenario creation--Half of the participants in each small group will proceed to create their own preferred nitrogen load scenarios (total nitrogen, source class and subclass allocations). The remaining half will proceed to a conjoint rating procedure. The scenario creation procedure will employ the *Source Scale Display* used for the presentation above, now activated in an interactive mode. Participants will be able to individually move the nitrogen load markers to represent their preferred total nitrogen loads and source allocations. The sea grass scale marker will not be adjustable, but will move to represent the expected effects on the bay of each change in total nitrogen. The scenario creation procedure places the participant in a “management perspective” context; i.e., the participant must set an overall nitrogen level for the bay (with the associated sea grass coverage-ecological conditions) and then specify which sources will be reduced by what amounts to achieve that level. In contrast the conjoint rating procedure (described in the next section) will require participants to express their preferences by choosing among (and rating) a set of predetermined total nitrogen/source allocation scenarios strategically constructed by the investigators. The choice procedure puts the respondent in a “citizen-consumer” context. Analysis of similarities and differences in preferences expressed from these two perspectives is an important part of the converging operations strategy of this assessment.

Participants assigned to the scenario creation procedure will first be given a brief tutorial on how to use the interactive scale display. They will learn to move the total nitrogen marker using the computer mouse. As the total nitrogen marker moves, the sea grass scale marker will move (with a noticeable delay) to the location implied by the nitrogen load scale. Movement will be based on the functional relationship between nitrogen and sea grass coverage to be determined in collaboration with the appropriate TBEP and other cooperators' technical staffs. Participants will be encouraged to move the scale back and forth to explore the relationship between nitrogen loads and sea grass coverage (the selected key indicator of ecological condition in the bay). The sea grass coverage scale can not be directly adjusted, but will respond to movement of the total nitrogen scale marker.   The 1950 and 1976-78 values, now familiar to participants will be designated to define the endpoints of the total nitrogen and sea grass scales, and 1992-94 and 2001 (2002) levels will be indicated to anchor the middle regions of the scales. The TBEP target of 38,000 acres of sea-grass coverage (the 1950 coverage minus permanently altered areas) will be indicated as the estimated maximum potential future coverage.

The tutorial will then move to the major source class scales. The markers for these scales will be moved one at a time, with the remaining scale markers automatically "harnessed" to maintain the set value of the total nitrogen load and to preserve the TBEP target (1992-94) relative load allocations. Movement of a source-class scale marker will automatically produce adjustments to the associated subclass markers to achieve the indicated load for the class without altering the load allocations among subclasses. The tutorial will then proceed to the subclass markers, which may also be moved one at a time, with the constraint that the associated source-class marker will remain at the indicated setting. As each subclass marker is adjusted, the remaining subclass markers within the source class will move automatically to achieve the set total for the class, preserving their relative allocations. Appropriate minimum achievable values (establishing maximum possible reductions) will be determined and indicated on each source class and subclass scale and participants will be instructed that no source may be set below this limit. Participants will be reminded that there may several different ways to achieve reductions in each source, and that it is progressively harder to achieve further reductions in any source as the minimum achievable level is approached.

Following the tutorial, participants will be given a brief “test” to insure that they understand how to use the scales. They will then proceed individually to create their own preferred nitrogen load/source-allocation scenarios. The beginning point for all scales will be the previously projected values for 2010, assuming no further actions to maintain current nitrogen loads in the bay. The "rules" of the creation procedure are that the participant must first set the total nitrogen scale to their preferred position (above the 2,000 T/y minimum) by moving the marker arrow with the computer mouse. The sea grass coverage scale will move automatically (with an upper limit of 38,000 acres) with the total nitrogen scale, but can not be moved directly by the participant. The source class and subclass scales will automatically move proportionately to achieve the indicated total nitrogen load without altering the allocation among subclass scales. The participant may choose to exit this part of the procedure at this point, accepting the original allocations among sources and sub-sources (essentially consistent with the TBEP allocation plan). If selected total nitrogen settings require one or more source class and/or subclass scale to move below their indicated minimum achievable levels, the participant will be alerted that a reallocation of source class and/or subclass loads will be required.

If the participant wishes (or is required) to adjust the allocation among source classes, he/she will then select one of the major source-class scales and adjust that scale by moving the marker arrow up or down (using the computer mouse). *Stormwater Runoff*, *Discharge*/*Spills*, and *Atmospheric Deposition* may be adjusted, but the groundwater/*Spring* scale will remain fixed throughout the session. When the first chosen scale is moved (up or down) the remaining two scales (and the associated subclass scales) will automatically adjust proportionately (without changing their relative load allocations) in accordance with the fixed total nitrogen load. When the first chosen source-class scale has been set, the participant may select the next source class scale to adjust, or indicate that they are satisfied with the displayed allocation and exit this part of the procedure.

Setting the second major source scale (the first remains fixed) will force the third scale into a final position. The participant can accept the indicated major source class allocation, reset the source classes to their initial positions (keeping their total nitrogen setting and repeating the adjustment procedure), or reset the entire display to the original positions and start again by moving the total nitrogen marker to a new position. If selected settings move any subclass scale below the marked minimums, the participant will be alerted that additional source adjustments will be required.

With total nitrogen and major source class allocations fixed, the participant may proceed to adjust the sub-class loads within each source class. For example, the allocation of loads can be adjusted within the *Stormwater Runoff* source class by first selecting one of the subclass scales and moving the load marker to the preferred position. The remaining two moveable subclasses (the *Undeveloped/rangelands* subclass will remain fixed throughout the procedure) will automatically move appropriate to the fixed source class load, retaining their original relative allocations. The second subclass scale can then be selected and adjusted, with the third automatically moving accordingly. All subclass scales must be set at or above their marked minimum achievable levels.

The participant may then accept the indicated subclass allocation, or reset the subclasses and begin again. If desired, the participant can proceed to adjust subclasses within the next major source class. The *Atmospheric Deposition* source class offers three subclasses and the *Discharge/Spill* source class offers two (so only one subclass scale adjustment is possible). Final scale values set by each participant will directly indicate the preferred levels of total nitrogen, and the preferred pattern of source class and subclass reductions for achieving those levels.

Conjoint rating elicitation procedure--This value assessment procedure will provide an expression of preferences for specified sets of total nitrogen and source allocation scenarios from a “citizen-consumer” perspective. Scenarios will be presented in pairs and the participant will indicate which member of each pair is most preferred, and then rate the magnitude of the preference difference between the two alternatives by allocating 100 points between them (e.g., 100/0, 60/40, 50/50).

If total nitrogen levels and major source and subclass allocations were all free to vary an infinite set of scenario alternatives could in principle be developed. The number of different 2010 scenarios will be systematically constrained to create a total of 30 paired comparisons. The specific "critical" alternatives to be created are summarized in the table below.

Total Nitrogen/Sea Grass Comparisons: *source allocations fixed, 2010/20 standard*		
	Low Load (approx. 2800 T/y, with sea grass maximized at 38,000 acres)	
	TBEP Target (3800 T/y - 38,000 acres)	
	Moderately High Load (approx. 4800 T/y - 28,000 acres)	
Major Source Class Comparisons: *total nitrogen and subclass allocations fixed, TBEP standard*		
	Stormwater runoff reduced to minimum (other classes reduced proportionately)	
	Direct Discharge/Spill reduced to minimum	
	Atmospheric Deposition reduced to minimum	
Subclass Comparisons: *total nitrogen level and major class allocations fixed, TBEP standard*		
	Stormwater Runoff Class	
		Residential runoff reduced to minimum (others reduced proportionately)
		Commercial/Industrial runoff reduced to minimum
		Agricultural runoff reduced to minimum
	Direct Discharge/Spill Class	
		Municipal wastewater discharge reduced to minimum
		Industrial waste/fertilizer spills reduced to minimum
	Atmospheric Deposition Class	
		Power Plant sources reduced to minimum
		Commercial/Industrial sources reduced to minimum
		Mobile sources reduced to minimum

Alternatives will represent a range of total nitrogen levels/sea grass coverage (with source allocations fixed), major source allocations (one at a time, with total nitrogen and subclass proportions fixed) and subclass allocations (varied one at a time, with total nitrogen and major source allocations fixed). To further reduce the number of possible comparisons a common "standard" scenario will be created and compared against each of the other alternatives within each set. The standard scenario for the total nitrogen alternative set will have total nitrogen/sea grass coverage and all major and subclass allocations fixed at the projected 2010 (2020) levels without the TBEP nitrogen reduction program (i.e., 5775 T/y, with appropriate projected sea grass coverage). The standard alternative for the Major Source Class and for the Subclass sets will be the TBEP target of 3800 T/y - 38,000 acres, with source allocations as in 1992-94.

Each of the 14 alternatives listed in the table above, along with the No-TBEP/2010 (2020) and the TBEP-target standard alternatives, will be created and displayed using a facsimile of the *Source Scale Display* system described above. Pairs (the appropriate standard and an alternative) will be presented together on a computer screen with the scale markers set to the positions appropriate to the respective alternative. Sixteen additional pairs will be created by contrasting selected individual alternatives from within the total nitrogen, major source class, and subclass sets (e.g., Low versus TBEP-target, Runoff minimum versus Air Deposition minimum, Mobile versus Power Plant minimum). These pairs will allow testing of the transitivity of individual choices, as well as providing some variation from the standard-alternative pair presentations. Assignment of alternatives to locations on the screen (top versus bottom) and the order of choice-pairs will be randomly determined for each participant.

Responses will be registered by mouse clicks on buttons shown on the computer screen. Participants will first be required to indicate the preferred alternative, and then indicate a position on a 0/100 - 100/0 scale to record their rating of the magnitude of preference difference between the alternatives evaluated. Choice and rating data will be directly recorded into a database.

Preferred means for achieving indicated reductions--Once the participant accepts a final total nitrogen load and source allocation or completes the conjoint rating procedure, he/she will be asked to rank the alternative means of achieving the selected load targets in each subclass. Participants will be asked to assume that substantial reductions are required from a given source subclass (e.g., *Atmospheric Deposition--Mobile* sources) and then presented with 3 to 5 alternative means of achieving that reduction. For example, the options for the mobile atmospheric source may include:

> *reinstate emissions testing and standards for automobiles* (a recently discontinued program);
> *develop a public transportation system* (similar to the light rail recently proposed for the Olympics development);

require special gasoline additives (increasing the cost of fuel); or
impose a special tax on automobiles based on fuel consumption. [4]

The options within each of the 8 (3 + 3 + 2) source subclasses will be ranked individually by each participant. The order of presentation of subclasses and means-options within subclasses will be randomized for each participant. Participants will be reminded that each option implies some "costs" to individuals and to the community, and that some of the options may provide "fringe benefits" beyond the effects of reducing bay-nitrogen loads. Participant responses will be recorded on-line and ranks for each option within each subclass will be used to calculate preference indices for each means of achieving nitrogen reductions. Reduction-means preference scores will be compared within and between small groups and (later) represented stakeholder groups.

Respondent characteristics--Finally, each participant will answer a short set of questions to determine relevant personal characteristics. Demographic items will generally classify participants in terms of age, education, household income, and gender. Zip code will determine residence location relative to the bay. Other questions will classify participants with respect to length of time in the area, frequency and types of direct and indirect uses and experiences of the bay and relevant interests/concerns, including memberships in relevant special interest groups or organizations.

Converging operations analysis--Indicated source levels from the scenario creation procedure will be scaled (standardized) individually and compared across participants within and between small group sessions (and later across stakeholder groups) to assess internal consistency and to identify any significant conflicts or minority opinions. Total nitrogen settings (T/y) will be treated as ratio-scaled measures in the analyses. ANOVA will be used to compare preferred total nitrogen loads between sessions and stakeholder groups. Source class and subclass settings may be treated as either ordinal or interval scale values, constrained by the individual total nitrogen settings selected by each participant. Correlation and regression analyses will be used to explore the interrelationships among source classes and subclasses and to identify distinguishable preference patterns within and between the stakeholder groups represented. The conjoint rating procedure will yield percent choices (and standardized paired comparison scales) and mean difference-magnitude ratings (and standardized scale values) computed for each of the alternatives within total nitrogen, major source class and subclass sets. Obtained values will be used as the indicators of preference weights for total nitrogen/sea grass coverage, and nitrogen-source reduction priorities within respective major source class and subclass alternative sets.

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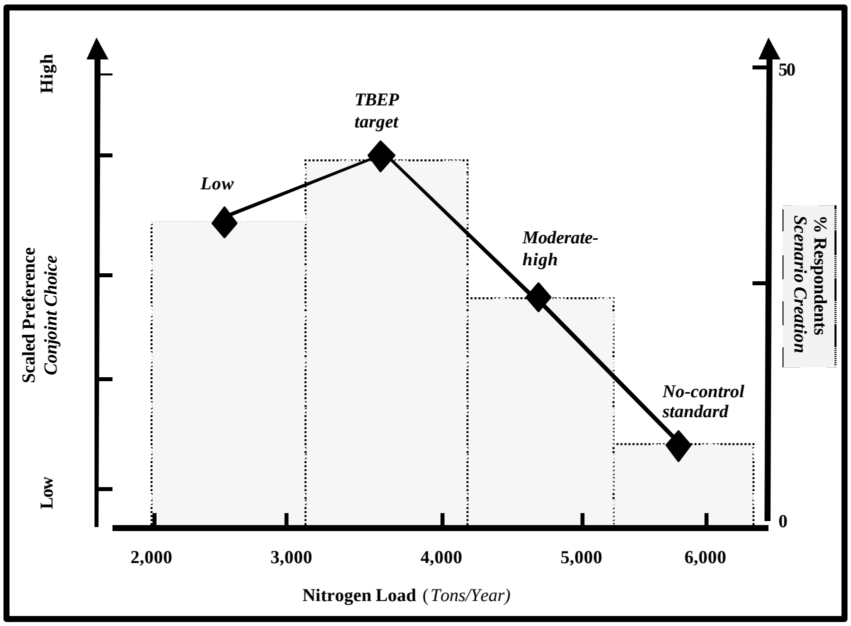
[4] It may be possible (if appropriate cost functions were available) to include specific dollar costs for achieving reductions in some or all of the source subclasses. The benefits of doing so would be some opportunity to infer "willingness-to-pay" values (given typical economic valuation assumptions), but at the expense of further complicating the task for participants.

Choices and ratings of total nitrogen alternatives in the conjoint rating (citizen-consumer) procedure will be analyzed to produce a preference scale over the range of alternatives tested (including the standard). Discriminant validity of the assessment will be indicated by significant differences across the tested total nitrogen and source allocation options. The psychophysical function relating expressed preference to total nitrogen load may not be monotonic. Public support for the TBEP program would be indicated by an inverted U function, as illustrated below, with both higher and lower nitrogen-load alternatives being less preferred than the TBEP-target load.



To be consistent, the frequency distribution of preferred total nitrogen values (aggregated into categories consistent with the choice alternatives) derived from the scenario creation procedure should produce similar results. The frequency distribution of preferred total nitrogen levels should show a similar inverted U pattern, and have a mode at the TBEP-target load. Alternatively, the choice-derived scale and/or the scenario-creation values could indicate a maximum preference above (or below) the TBEP target, indicating a difference between public preferences and the nitrogen management program goals. The correspondence between choice derived and scenario created nitrogen-preference functions provides an indication of convergent validity (method invariance) between the citizen consumer and manager perspectives. Divergence between these two scales will be inspected to determine the nature of context effects that might be expected in direct public response to the assessed nitrogen management options.

Source class and subclass allocation preferences directly indicated in the individual scenario-creation procedure will be compared (correlated) with the preference weights implied by the conjoint choice/rating procedure. Values from the interactive scale method and from the conjoint rating procedure should be consistent, as indicated by high positive correlations between source class and subclass scale values/weights. To the extent source-class values are consistent, the convergent validity of source allocation preferences from both procedures will be indicated, and confidence in their mutual conclusions will be increased. Where source allocations/weights differ significantly the specific patterns of differences will be inspected to determine the implications for preferences elicited by direct experience of the assessed policies and outcomes.

The small group session will be completed by a review and general discussion of the results with the participants. Summary statistics and charts will be displayed immediately, along with the results of the analysis of the initial verbal questions. Discussion will be directed at identifying and explicating points of consensus and disagreement among the respondents, including any observed differences between elicitation procedures. The goal of this review is allow respondents to see and comment on the implications of their expressed/implied preferences, and to review participants' final understanding of the issues. The presentation and preference elicitation procedures used in this assessment will also be reviewed and evaluated at this time with the goal of developing the general survey procedures.

Stage 3: General survey

The small group sessions will provide an assessment of the preferences of high-interest participants, in a high-information interactive group context. Informed and carefully reasoned preferences from key stakeholder groups are important guides to policy making, but they may not be representative of general public reactions, which are likely to be based on less information and less carefully considered reasoning. A more general, more representative survey of pubic preferences provides another important perspective for managers and policy makers, and may be especially important in negotiating any conflicts among the more intensively concerned (minority) stakeholder groups. Thus, a short (approximately 20 minutes per respondent) general survey of a more broadly representative sample of Tampa Bay area residents will be developed and implemented to extend the findings from the small group sessions. The general survey will employ a subset of the setting/history and other materials used for the small groups, and emphasize elicitation of preferences for a more limited set of key policies/outcomes. Experience with and evaluations of the small group procedures will be used to guide development of the specific materials and procedures for the general survey.

Survey design-- An interactive, computer implemented "questionnaire" distributed over the internet (www) will be the primary format for the general survey. The goal of the internet survey is to achieve an assessment of nitrogen load and source allocation preferences based on a broader sample of Tampa Bay residents. Key historical background and nitrogen process information will be presented in an abbreviated form. A smaller set of source allocation options will be presented and preference expressions will be restricted to choices among fewer alternatives. Direct source allocation adjustment procedures (if implemented) may be simplified and more limited.

Survey sampling--Interactive computer systems provide important advantages for the presentation of complex environmental process and condition information, and for communicating public preferences and concerns. At the same time, achieving a truly representative sample of any general public population is potentially hampered by the lack of universal access to adequate networked computing equipment and by the operating skills of participants. Much as in early telephone surveys, sampling biases could have serious effects on the external validity/generalizability of findings.

The proposed assessment will address sampling problems in several ways. First, the small group sessions described above will provide an indication of the range of preference differences (and consensus) that may exist among the specifically targeted special interests represented. Second, a series of intercept-sample interviews will be conducted in central locations (e.g., major shopping centers or other frequently used public venues) strategically distributed across the Tampa Bay area. At each location a suitable space will be secured and equipped with a number of networked computers (or arrangements may be made to use an existing computer facility). Potential participants will be approached and invited to participate in the survey. Finally, a formal random sample of Tampa Bay area households will be selected and solicited by mail to participate in the interactive internet (www) survey.

Survey implementation--To address the obvious problems of computer access in the mail solicitation procedure, an analog of the Dillman multiple-contact procedures will be applied. First, a random sample of households in the three bay-adjoining counties will be selected and contacted by mail. Introductory and motivational materials and instructional/tutorial information for accessing and performing the survey on the internet will be provided. In addition, each potential participant will be provided with a card with a unique identification code. Those who have access to a suitable networked computer will be asked to log on to a specified web site to participate. For those who do not have direct access to a suitable computer, a list and directions will be provided to a number of suitable public (e.g., libraries, schools) and private (e.g., internet cafes) facilities in the community that have been solicited to cooperate in the study. After two weeks (the time specified for responding) a second mailing will remind those who have yet to respond, again providing the identification code and access information, and urging their participation. In addition, the schedules (several full days scattered over the following two weeks) and locations for the intercept interviews will be provided, along with an invitation to come by with their identification code and participate. Finally, after the second two-week period those who have still to reply will be contacted by telephone and solicited for a personal interview/survey at their home or other desired venue. An interviewer equipped with a laptop computer will meet the participant at the designated time and place and conduct the survey.

Careful records will be maintained regarding the specifications determining the original mail-out sample and the members of that sample that participated at each stage of the progressive solicitation process. Comparison of specification parameters (geographic and demographic) will indicate how well the obtained sample matched the original randomly selected sample. Demographic, bay-use and relevant interest characteristics of participants in the intercept interviews and the separate stages of the mail solicitation survey will be compared for further indications of bias in the final samples. The representativeness of the overall value assessment will be indicated by the correspondence between mail-out sample parameters and the characteristics of final participants within and across the selected small groups, intercept and mail-solicited samples.

Analysis of results of the general survey will parallel those described for the small group sessions above. The principal data are the functional relationships between total nitrogen and source allocations and the measures of preference obtained. If choices and/or scale adjustments indicate that the TBEP nitrogen/sea grass targets are the most preferred, public support of the program would be indicated. Overall or identifiable subgroup preferences for lower or higher total nitrogen or source allocation targets would indicate areas where program goals may need to be changed, or where public education and involvement efforts may need to be increased. Rankings of the various means of achieving desired nitrogen reductions for each source subclass indicate the relative acceptability of these options, and should suggest operational priorities for management programs to achieve nitrogen goals.

Background and Related Research

The conceptual basis for this assessment is drawn from psychological theory and research in perceived environmental quality assessment (e.g., Craik & Zube, 1977; Daniel & Vining, 1983) and behavioral risk/decision sciences (e.g., Payne et al, 1992; Slovic et al, 1990). Central tenants of this model are that public environmental values are relative, not absolute (Kahneman et al, 1999), and that particular value hierarchies are largely constructed, rather than retrieved (Fischoff, 1991; Gregory, 2000; Slovic, 1995), and thus are highly sensitive to contextual factors created by the assessment process. At a more fundamental level the approach taken in this assessment is consistent with contemporary "modular" or "multiple-channel" models that characterize the human information processor as a collection of distinct semi-independent psychological/neurological systems each specialized to accomplish particular cognitive, affective and behavioral tasks (e.g., Buck, 1985; LeDoux, 1995; Milner & Goodale, 1996). In this model, values are expected to be multidimensional, situational and not necessarily commensurate. Causal relations will sometimes run from values to preferences to actions, and sometimes the reverse (e.g., Zajonc, 1980). For some value assessment models the apparent inconsistencies, incommensurabilities and intransitivities would be interpreted as serious faults in valuation logic. For psychologists (and for public environmental managers) they are facts of life.

An important implication of the basic modular-contructivist model for public environmental value assessments is that each assessment must determine what the appropriate valuation context should be. That is, the assessor must determine the specific means for representing the relevant management actions-environmental outcomes at issue, the media and procedures for presenting those representations to observers-participants, and the methods and formats for eliciting and recording the overt indications of preferences/values for those alternatives. The "right" context is that which will lead to valid and useful projections of preferences, support and/or compliance when the assessed policies-conditions are realized and encountered in the "real world"(Daniel, 1992; Daniel & Meitner, 2001). To the extent that realized environmental preferences/support/actions depend upon perceptions, understandings, emotions and/or other psychological processes that are not adequately or appropriately elicited by the assessment procedure, then, however elegant, internally consistent or logically correct, the resulting value assessments will not be valid--or useful to managers. While the desired goals for value assessment design are clear enough, achieving the "correct" assessment is at least problematic.

Environmental value assessments are substantially constrained by the current state of knowledge about the subject environmental problem-system, by technical limitations of management implementation systems and facilities, and by typically large uncertainties about future environmental conditions, mostly induced by events and processes outside of human control. On top of these environmental science and management technology limitations, the target for assessments is typically *future* values, requiring rather strong assumptions about the temporal stability of contemporary preferences (support, compliance), sometimes extended to generations not yet born. It follows that it is unrealistic to believe that any currently feasible environmental value assessment procedure could achieve (or prove) perfect validity. Assessment procedures can seek to represent as closely as possible the environmental, social and behavioral contexts that are expected to obtain at the places and times that the subject environmental management policies-outcomes will be encountered. Whatever surrogate representation of the target valuation situation is selected, the validity of the assessment results should be supported by systematic tests (e.g., Campbell & Fiske, 1959: Cronbach & Meehl, 1955).

While “ultimate” validity is not a realistic target for environmental value assessments, there is some knowledge about the relative advantages and limitations of available and feasible representational and procedural options. Contrary to frequent practice, empirical research and relevant psychological theory concurs that verbally expressed values for verbally described environmental/social conditions may address a peculiar and unrepresentative subset of value-relevant environmental perceptions and responses (e.g., Milner & Goodale, 1996; Weiskrantz, 1988). For many important environmental value dimensions, verbal descriptions are singularly inappropriate. Descriptions of the features of a landscape are generally not a sufficient basis for meaningful expressions of aesthetic preferences, except in the limited case where the differences among alternatives are very substantial and essentially categorical (Daniel & Ittelson, 1981). In cases where the relevant dimensions of environmental change are subtle and graded, verbal descriptions may beg the environmental values question altogether; *Which would you prefer, no pollution in the bay, a little pollution …?*

Graphic representations offer an attractive and frequently used alternative to words for representing value-relevant environmental conditions. Photographic representations have been an obvious choice for assessments focused on visual properties of the environment, and photographs have proven valid representations for assessments of landscape scenic beauty (e.g., Daniel & Boster, 1976; Shuttleworth, 1980; Zube, 1974) and visual air quality (Latimer et al, 1981; Malm et al, 1981; Stewart et al, 1984). Computer simulation and visualization techniques, such as digital video imaging (e.g., Orland, 1993; Vining & Orland, 1989) have expanded representational options. Tests of the representational validity of digital images have largely been successful (e.g., Bergen et al, 1995, Oh, 1994), but there are indications that very near photographic quality is required (Daniel & Meitner, 2001). Computer simulations are playing an increasing role in environmental planning and in environmental perception research (e.g., Marans & Stokols, 1993; Sheppard, 1989). Simulation models have been effectively coupled with computer graphics systems to achieve more sophisticated and better-controlled environmental representations (e.g., Bishop & Hull, 1991; Clay & Gimblett, 1998; House et al, 1998; Thorn et al, 1997). Techniques that combine computer simulation modeling with map and 3-D terrain graphic displays (e.g., Bishop et al, 1995; Pietsch, 2000) offer the promise of better representing environmental problems that involve complex geographic and spatial relationships, but systematic tests of the validity of these representations remain to be done. "Virtual reality" technologies are advancing at an astonishing pace, offering assessors expanding opportunities for animated and interactive environmental representations (e.g., Bishop et al, in press; van Veen, et al, 1998; Verbree et al, 1999). Only a few systematic tests of the representational validity of these systems have so far been attempted, but results are encouraging (e.g., Rohrmann & Bishop, 2001).

Appreciation of the TBEP nitrogen management program requires an understanding of a number of complex biophysical processes with effects that extend over space and time. Managers' understanding of the problem, and the possible solutions to it, is supported by years of scientific training and by large volumes of relevant geographic and historical data. Meaningful public involvement in the nitrogen management decision process requires that they share some of this training and information. The proposed assessment procedure applies a number of environmental representation and communication methods that have admittedly not been tested in the specific context of problems like the management of nitrogen pollution in Tampa Bay. For that reason, the assessment has been designed to allow systematic comparisons across several methods of environmental representation and several modes of response. While this converging operations strategy may not be maximally efficient, it does provide for explicit tests of the validity of assessment results, offering important protection in a situation where the "correct" procedure cannot be known.

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Tampa Bay Estuary Program Values Assessment: Charting Publicly Preferred Passages

Terry C. Daniel and Michael J. Meitner

Attachment

Schedule and Budget

Reply to Reviews

Proposed Project Schedule

Task		Date
Project initiation		July 1, 2001
Biophysical scenarios developed and verified		September 1, 2001
Representation materials and presentation procedures developed and tested		January 1, 2002
Small group interactive assessments completed		April 1, 2002
General internet survey design developed		September 1, 2002
Survey materials and procedures developed and tested		January 1, 2003
Intercept and internet survey completed		March 1, 2003
Results review and feedback completed		May 1, 2003
Final Report		June 30, 2003

Proposed Project Budget

		Year 1		Year 2		Totals
Salaries						
PI		$17,616.90		$9,227.90		$26,844.80
GRA		$14,979.30		$7,489.65		$22,468.95
RA		$3,000.00		$3,200.00		$6,200.00
ERE		$4,440.76		$2,325.58		$6,766.34
Operational Expenses						
Sub-contracts						
UBC visualization		$30,000.00		$20,000.00		$50,000.00
on-site services		$5,000.00		$5,000.00		$10,000.00
Participant expenses		$15,000.00		$5,000.00		$20,000.00
HW/SW		$5,000.00		$3,000.00		$8,000.00
Supplies		$2,000.00		$3,000.00		$5,000.00
Travel		$6,000.00		$3,000.00		$9,000.00
Total Direct		$103,036.96		$61,243.13		$164,280.09
MTDC		$88,036.96		$51,243.13		$139,280.09
TDC - .50 (UBC contract)						
Indirect (25% MTDC)		$22,009.24		$12,810.78		$34,820.02
Project Totals		$125,046.20		$74,053.91		$199,100.11

Notes to budget

Detail for Salaries

Salaries	Year 1 Base (annualized)	Year 1 %	Year 1	Year 2 Base (annualized)	Year 2 %	Year 2
PI (Daniel)	106,014.67	16.6	17,616.90	108563.53	85	9,227.90
GRA	31,938.81	46.9	14,979.30	32869.97	22.8	7,489.65
UGRA (temp)	3,000.00	100	3,000.00	3,200.00	100	3,200.00

Subcontract (UBC) Details

	Year 1	Year 2	Totals
Student RA (inc benefits)	11,271.00	11,299.00	22,570.00
Programmer	3,375.00	1,000.00	4,375.00
Travel	6,000.00	4,000.00	10,000.00
Computer Lab Fees	7,925.00	2,750.00	10,675.00
Total Direct Costs	28,571.00	19,049.00	47,620.00
5% Overhead	**1,429.00**	**951.00**	**50,000.00**

On-site Services (estimated)

Year 1	Year 2
Temporary hire, local assistants estimated 300 hrs @ 16.67/hr	Temporary hire, local assistants estimated 300 hrs @ 16.67/hr

Participant expenses (Estimated)

Year 1 (small groups)	Year 2 (intercept and general survey)
Participants: 4 sessions x 15 @ 150 ea = 9,000.00	5 venues @ 200/da ea = 1000
Rent computers 4 session x 15@ 100ea = 6,000.00	160 paid participants @ 25ea = 4000

Hardware/Software and Supplies (over $1000)

One laptop computer with wireless network card $2, 700.00

Travel

Year 1	Year 2
Trip 1 Tucson -Tampa return T Daniel (10 days) Meet TBEP staff, arrange small group venues **Trip 2** Tucson - Tampa, return T Daniel + 1 Grad Res Assistant (10 days) Conduct small group sessions	**Trip 1** Tucson -Tampa return T Daniel + 1 Grad Res Assistant (10 days) Conduct intercept survey